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Patents Form 1/77

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01APR99 E437024-1 D00355
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Cardiff Road
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Request for grant of a patent

(See the notes on the back of this form. You can also get an explanatory leaflet from the Patent Office to help you fill in this form)

1. Your reference — Q037280PGB

2. Patent application number *(The Patent Office will fill in this part)* — 9907475.9 — 30 MAR 1999

3. Full name, address, and postcode of the or of each applicant *(underline all surnames)*

The University of Birmingham
Edgbaston
Birmingham
B15 2TT, ~~England~~.

SECTION 30 (1977 ACT) APPLICATION FILED 12.4.00

Patents ADP number *(if you know it)* — 79816502

If the applicant is a corporate body, give the country/state of its incorporation — England

4. Title of the invention — DISPENSE TAP ASSEMBLY

5. Name of your agent *(if you have one)* — ~~Marks & Clerk~~ — Frank B. Dehn & Co

"Address for Service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*

~~Alpha Tower~~
~~Suffolk Street Queensway~~
~~Birmingham B1 1TT~~

179 Queen Victoria Street
London EC4V 4EL

Patents ADP number *(if you know it)* — ~~18002~~ — 166001 — 51/77 12.4.00

6. If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and *(if you know it)* the or each application number

Country	Priority application number *(if you know it)*	Date of filing *(day / month / year)*

7. If this application is divided or otherwise derived from an earlier UK application give the number and filing date of the earlier application

Number of earlier application	Date of filing *(day / month / year)*

8. Is a statement of inventorship and of right to grant of a patent required in support of this request? *(Answer 'Yes' if:* — YES

a) any applicant named in part 3 is not an inventor, or
b) there is an inventor who is not named as applicant, or
c) any named applicant is a corporate body.
See note (d))

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9. Enter the number of sheets for any of the following items you are filing with this form. Do not count copies of the same document.

Continuation sheets of this form	
Description	9
Claim(s)	
Abstract	
Drawing(s)	3 + 3

10. If you are also filing any of the following, state how many against each item.

Priority documents	
Translations of priority documents	
Statement of inventorship and right to grant of a patent *(Patents Form 7/77)*	
Request for preliminary examination and search *(Patents Form 9/77)*	
Request for substantive examination *(Patents Form 10/77)*	
Any other documents *(please specify)*	

11. I/We request the grant of a patent on the basis of this application.

Signature Date

12. Name and daytime telephone number of person to contact in the United Kingdom — A R Pearce 0121 643 5881

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GB9907475.9

By virtue of a direction given under Section 30 of the Patents Act 1977, the application is proceeding in the name of

CARLSBERG-TETLEY BREWING LIMITED
140 Bridge Street
NORTHAMPTON
NN1 1PZ
United Kingdom

Incorporated in the United Kingdom

[ADP No. 06356349003]

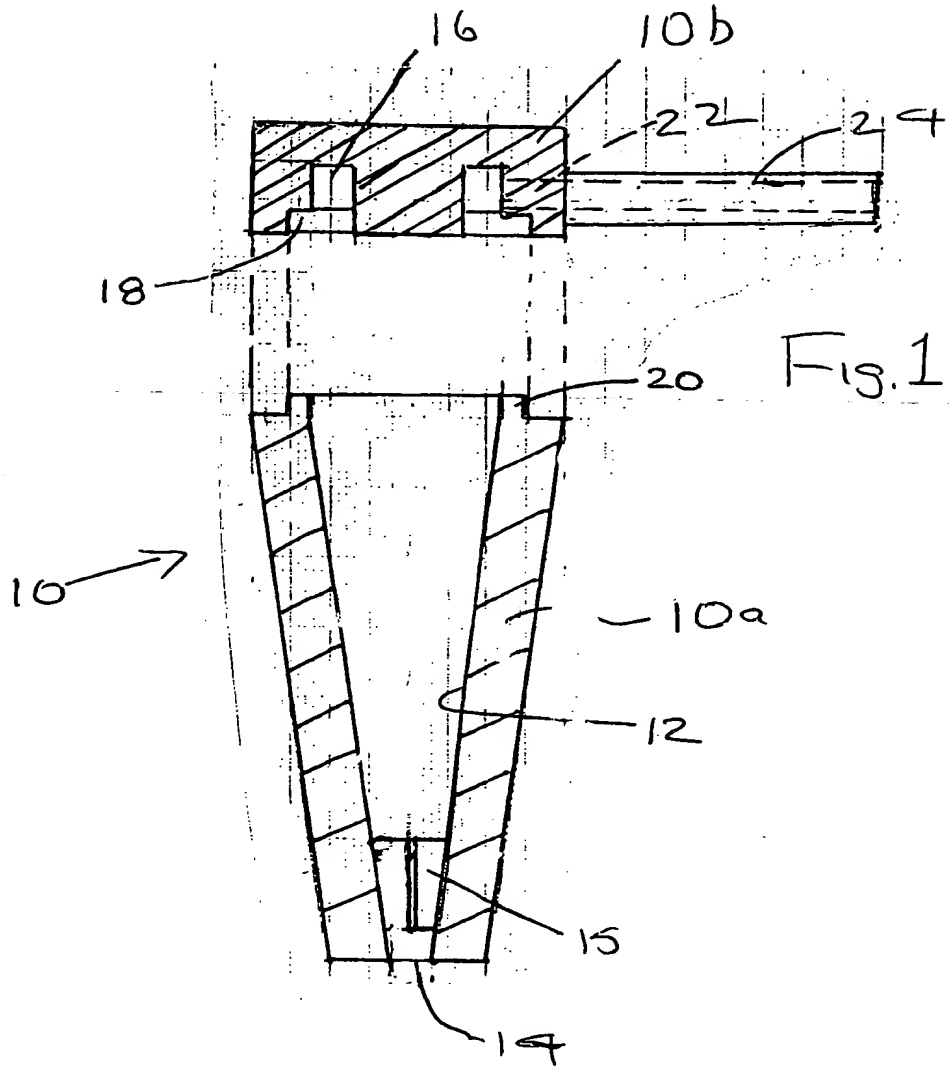


Fig. 1

Fig. 2

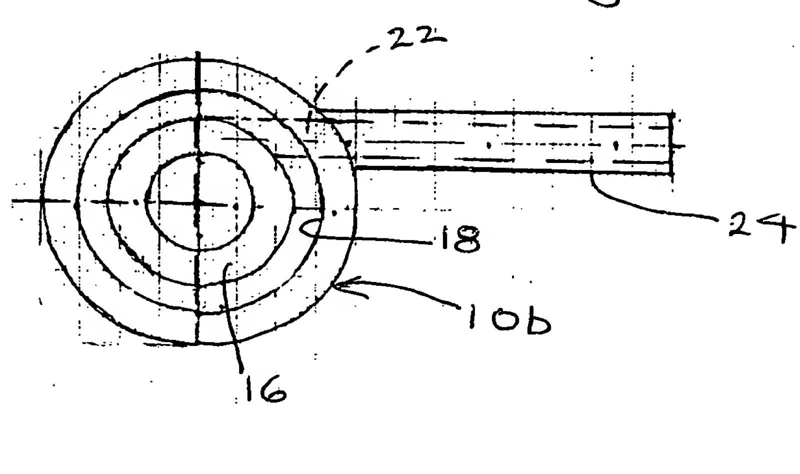


Fig. 3

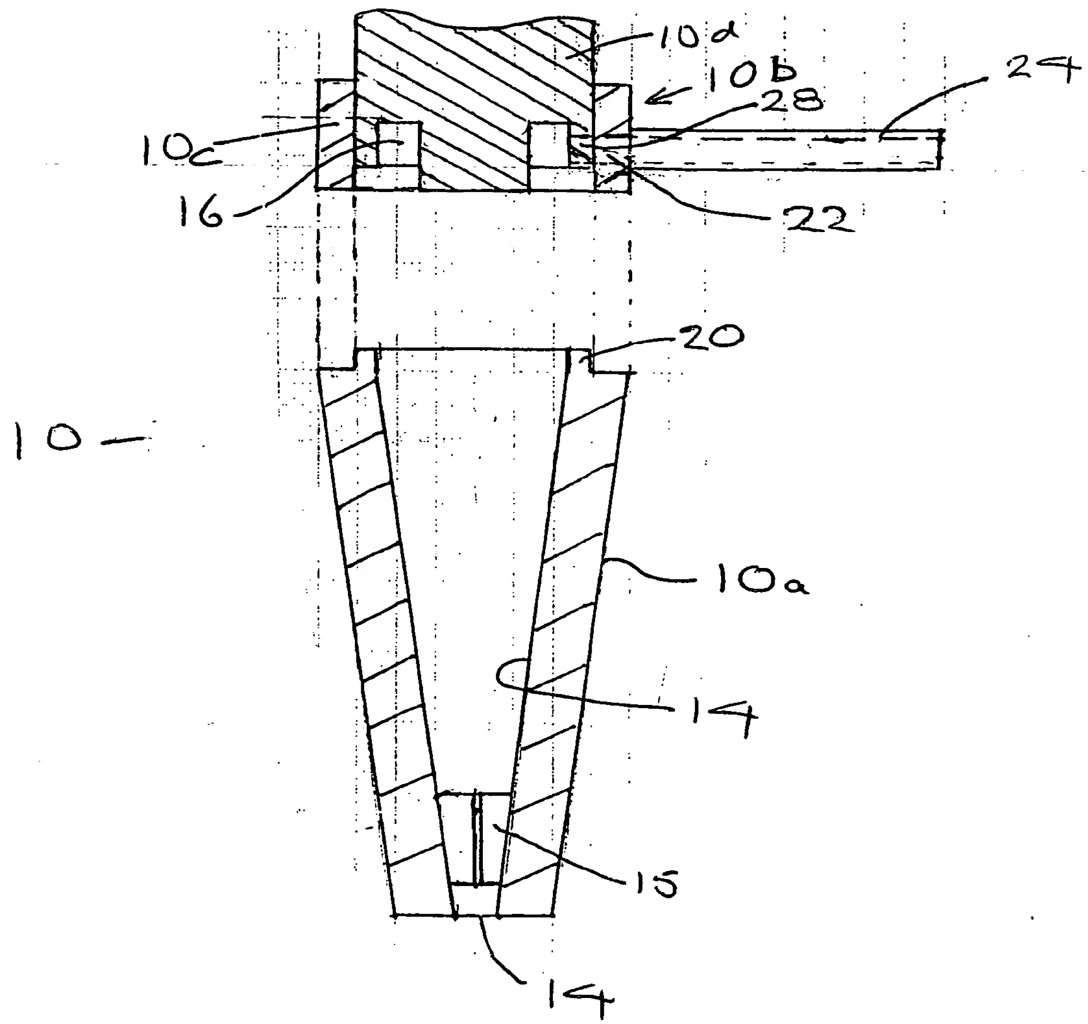
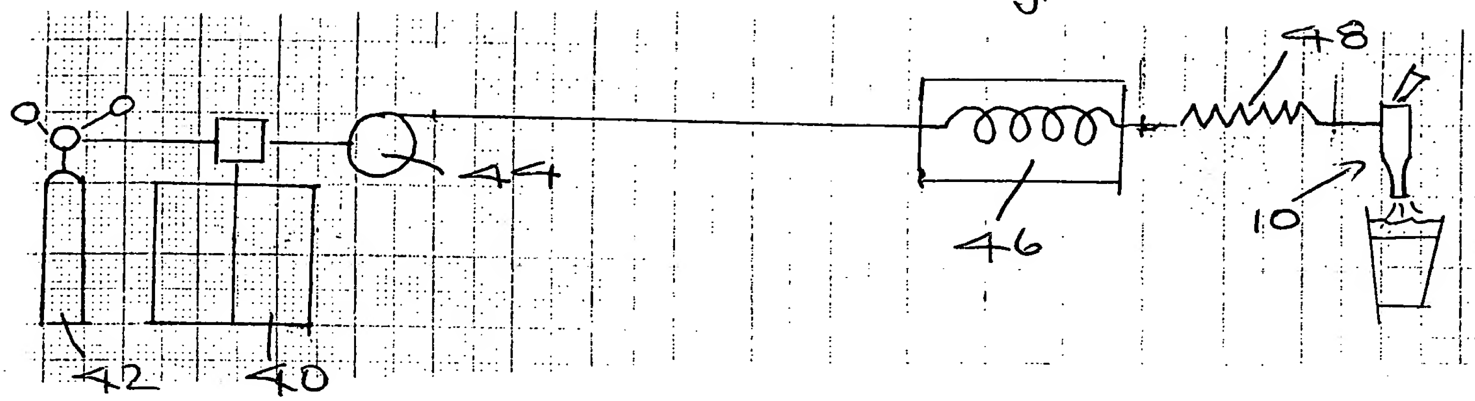
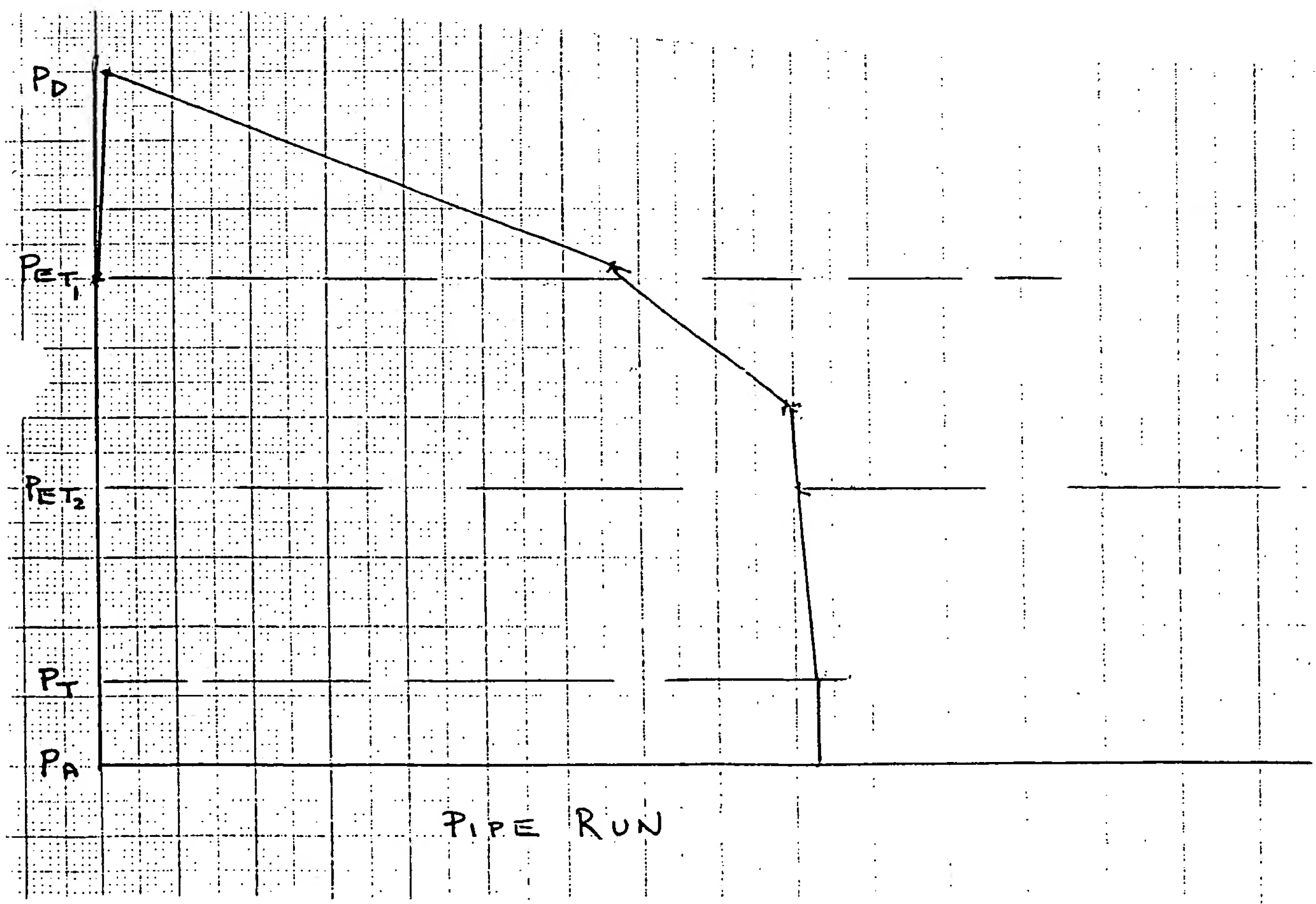


Fig. 4





DISPENSE TAP ASSEMBLY

This invention relates to a dispense tap assembly for a gasified beverage and is particularly, but not exclusively, concerned with a dispense tap assembly for beer which is to be dispensed from a keg or the like.

Beers currently marketed are generally of one or two types; ales typically containing 1.1-1.7%vol/vol of dissolved carbon dioxide and often 15-55 $mg.l^{-1}$ of dissolved nitrogen, or lagers containing 2.2-2.8%vol/vol of dissolved carbon dioxide. In either case, the beer enters the glass as a supersaturated solution which means that the dissolved gas it contains has the potential to break out of solution. The extent to which this occurs depends on a number of factors. These include the level of supersaturation, the flow conditions and the existence of nucleation sites to initiate bubble growth. During beer dispense, the generation of gas bubbles in solution originates predominantly by heterogeneous bubble nucleation. This means that bubbles are either nucleated at a surface containing pre-existing nucleation sites or in solution as a consequence of air being entrained in the beer as it flows into the glass. Both mechanisms for promoting head formation are exploited in standard beer dispense taps. In particular, the use of a restrictor disc in the taps through which the lower carbonated ales are dispensed is a means of deliberately entraining air in order to promote bubble nucleation.

When dispensing beer in a bar or other point-of-sale location, the beer is commonly stored in a keg at a remote location from the point of dispense. A gas cylinder which contains nitrogen, carbon dioxide, or a mixture of nitrogen and carbon dioxide is connected with the keg and serves to drive

beer from the keg to the dispense tap. In order to ensure that the beer is in the correct condition as it is supplied to the tap, it is common to pass it through a cooler and a pressure restrictor before it is delivered to the tap. In some installations, a pump is provided between the keg and the tap. In conventional beer dispense systems, the tap is a simple on-off tap which is spring biassed into its on and off positions. Prior to use, the dispense system is set up with the intention that the beer is dispensed at the correct rate and in the correct condition when the tap is fully open. Conventional taps have a simple plug valve member which is moved into and out of engagement with a valve seat providing a restriction through which the beer flows in a highly turbulent state. Downstream of the valve is a nozzle normally of uniform internal bore to bring the flow into a continuous stream. As a consequence of the valve design, especially if it contains a restrictor disc at the bottom of the nozzle, the pressure drop across it is high and the transition of the beer from an unsaturated to a supersaturated state often occurs within the tap itself. The intrinsic design of these valves does not readily allow controlled break out of gas from beer and, hence the extent of beer head formation may be variable.

It is an object of the present invention to provide an improved beer dispense tap assembly.

According to one aspect of the present invention, there is provided a gasified beverage dispense tap assembly having an outlet nozzle through which, in use, the gasified beverage is dispensed; wherein a vortex inducer (or vortex finder) is provided for inducing a free vortex in the beverage as it flows into the outlet nozzle, and a vortex breaker is provided in the outlet nozzle and is spaced downstream of the vortex

inducer whereby, in use, the free vortex induced in the beverage flowing along the outlet nozzle is substantially eliminated in the beverage being dispensed from the outlet nozzle.

The term "free vortex" as used herein means a vortex which occurs naturally as a result of the descent of the beverage down the outlet nozzle. Thus, in a free vortex, no external mechanical device (such as a rotary stirrer) is required to maintain the vortex once it has been induced. A typical example of a free vortex is one which exists when water flows under the action of gravity through the plug hole in a wash basin or bath.

Preferably, the outlet nozzle is internally tapered at a shallow angle, typically in the region of 7 to 10°.

In a preferred embodiment, the outlet nozzle is defined by a body having an inlet, and the vortex inducer (or vortex finder) comprises an annular chamber axially aligned with the outlet nozzle relative to which the inlet is arranged so as to feed beverage to be dispensed tangentially into the chamber.

The tap assembly may further include a valve, preferably an on-off valve, disposed upstream of the vortex inducer.

The valve may be disposed in a beverage feed line leading to the inlet. However, in an alternative embodiment, the valve has a rotary valve member in which the annular chamber is formed, the annular chamber having a tangential inlet port which is movable into and out of registration with a beverage feed supply passage upon rotation of the valve member.

The present invention also resides in a beverage dispense system comprising a dispense tap assembly according to the present invention, and supply means for supplying gasified beverage under pressure to said tap assembly, wherein said supply means includes a beverage cooler for controlling the temperature of the beverage and a restrictor for controlling the pressure of the beverage entering the tap assembly, the beverage cooler and the restrictor being arranged so that the beverage entering the tap assembly is substantially supersaturated with gas.

In the dispense tap assembly, the vortex motion in the beverage passing through the outlet nozzle creates a pressure gradient across the beverage between its free surface within the vortex and the inner wall of the outlet nozzle. A low pressure zone is generated along the vertical axis of the free inner surface of the vortex. Within this zone, the pressure is close to that of atmospheric conditions resulting in the beverage at the free inner surface of the vortex being in a highly supersaturated state. Under these conditions, dissolved gas breaks out from solution to form a gas core which, subsequently, becomes entrained in the liquid phase in the zone of the vortex breaker. This results in the beverage emerging from the nozzle containing a multitude of small bubbles. The presence of gas bubbles in the beverage being discharged into the glass facilitates the formation of a foam head on the beverage.

If the core gas zone is connected to atmosphere, air becomes entrained in the beverage being discharged from the outlet nozzle, thus further improving the head of foam on the beverage in the glass.

The vortex breaker is provided to avoid the beverage being discharged from the outlet nozzle in an undesirable fan spray. Thus, the vortex breaker has the effect of constraining the flow from the end of the nozzle as a continuous "stick" of liquid containing a multitude of small gas bubbles which then lead to the formation of a tight head of foam on the beverage in the glass.

An embodiment of the present invention will now be described, by way of example, with reference to the accompanying drawings, in which
Fig 1 is an exploded view in axial section through a beer dispense tap assembly according to the present invention (with "on"/"off" valve omitted),
Fig 2 is a plan view of the assembly of Fig 1,
Fig 3 is an axial section through an alternative embodiment of beer dispense tap assembly according to the present invention,
Fig 4 is a schematic diagram of a beer dispense system including a beer dispense tap assembly according to the present invention, and
Fig 5 is a graph showing the pressure profile within the beer dispense system.

Referring now to Figs 1 and 2 of the drawings, the beer dispense tap assembly comprises, in this embodiment, a two part body 10 having a lower body part 10a and an upper body part 10b. The lower body part 10a defines an outlet nozzle having a downwardly tapering frusto-conical internal surface 12 leading to a lower outlet orifice 14 through which beer is dispensed in use into a glass or other receptacle. In this embodiment, the frusto-conical internal surface 12 has a 7° taper angle.

Adjacent the outlet orifice 14, the outlet nozzle is fitted with vortex breaker 15 having four equi-angular spaced planar blade regions which extend both radially and axially of the outlet nozzle.

The upper body part 10b has an annular chamber 16 which is coaxial with the frusto-conical internal surface 12. The outer diameter of the annular chamber 16 is the same as the diameter of the upper end of the frusto-conical internal surface 12. The lower surface of the upper body part 10b has a recess 18 therein into which an upstanding annular rib 20 on the lower body part 10a is received. The annular rib 20 has a cylindrical inner surface of a diameter which is the same as the outer diameter of the annular chamber 16. Thus, the outer surface of the annular chamber 16 merges smoothly with the internal surface 12 of the outlet nozzle. The upper body part 10b has an inlet passage 22 which opens into the annular chamber 16 and which is directed tangentially of the latter. A beer supply pipe 24 is connected with the inlet passage 22 and leads from an on/off valve (not shown). The on/off valve has a flow passage therethrough which, in the "on" position provides a minimal pressure drop.

In use, when the valve is in its "on" position, beer which is very close to or in a supersaturated state and at a pressure in the range of normally 200 to 50 kPa (gauge pressure) is supplied to the body 10 via the pipe 24. The beer flows into the annular chamber 16 tangentially and travels circumferentially around the chamber. This induces the formation of a free vortex in the beverage as it flows into the frusto-conical internal surface 12. The free vortex motion within the outlet nozzle creates a pressure gradient across the beer between its free surface within the vortex

and the internal surface 12. Thus, a low pressure zone is generated across the vertical axis of the free surface of the vortex. Within this zone, the pressure is close to that of atmospheric, resulting in the beer at the free surface of the vortex being in a highly supersaturated state. Under these conditions, dissolved gas breaks out from solution to form the gas core of the vortex which, subsequently, becomes entrained in the liquid phase in the zone of the vortex breaker 15. This results in liquid emerging from the orifice 14 containing a multitude of small bubbles. The vortex breaker 15 is disposed so that the blade regions face the vortical flow direction of the beer passing down the internal surface 12 so as to re-direct the beer so that it emerges from the outlet orifice 14 "stick" of liquid. The presence of the gas bubbles in the "stick" of liquid leads to the formation of a tight head of foam on the beer in the glass.

It will be appreciated that the precise geometry of the outlet nozzle and the vortex inducer can be selected to suit the content of gas in the beer being dispensed so as to provide a controlled gas break-out from the beer as a result of the vortical flow of the beer through the outlet nozzle.

Referring now to Fig 3 of the drawing, the tap assembly of this embodiment is similar to that of Figs 1 and 2 and similar parts are accorded the same reference numerals. However, in this embodiment, instead of there being an on/off valve disposed upstream of the beer supply pipe 24, the working parts of the valve are defined within the body part 10b. For this reason, the body part 10b is formed of (i) an outer, rotationally fixed part 10c to which the beer supply pipe 24 is attached, and (ii) an inner body part 10d which is disposed coaxially within the body part 10c but which is axially rotatable relative thereto. The body

part 10d has the annular chamber 16 formed therein and has an inlet port 28 arranged such that, in one angular position of the body part 10d relative to the body part 10c, the inlet port 28 is in registration with the inlet passage 22 to allow tangential flow of beer into the annular chamber 16. In another angular position of the body part 10d relative to the body part 10c, the inlet port 28 is out of registration with the inlet passage 22 so that the flow of beer into the annular chamber 16 is prevented. A suitable control mechanism (not shown) is provided for switching the valve between its "on" and "off" conditions quickly so as to minimise the time when there is only partial registration between the inlet port 28 and the inlet passage 22.

Referring now to Fig 4 of the drawings, the beer dispense system includes a gasified beverage tap assembly 10 of the previously described type, and a supply for supplying beer to the tap assembly in a condition in which it is very close to or in a supersaturated state. The supply system includes a keg 40 in which the beer to be dispensed is stored. A gas cylinder 42 is provided for driving the beer from the keg 40 to the tap assembly 10. In Fig 4, a pump 44 is also shown. However, the pump 44 is only used in systems where a large pressure drop has to be overcome as a result of the location of the keg 40 relative to the tap assembly 10.

Adjacent to the tap assembly 10, there is provided a cooler 46 for cooling the beer to a predetermined temperature (typically about 8°C), and a pressure restrictor 48. The pressure restrictor 48 is conveniently in the form of a length of pipe which is of smaller internal diameter than that of the pipe work in the dispense system. The pressure restrictor 48 can be

"tuned" to provide the required pressure drop simply by cutting it to the required length.

In the beer dispense system of Fig 4, the pressure profile of beer being supplied is carefully controlled in the manner indicated by the graph of Fig 5. Within the keg 40, the beer is at an equilibrium pressure P_{ET1}. In this condition, assuming that there are no temperature changes, the dissolved gas is in equilibrium with the free gas in the headspace above the beer in the keg 40. In order to force beer from the keg, the pressure applied to the surface of the beer in the keg 40 is increased to P_D from the cylinder 42. Alternatively, pressure P_D may be achieved by use of pump 44. This increase in pressure maintains the dissolved gas in solution so that there is substantially no gassing out as the beer passes along the pipework leading to the cooler 46 despite the inevitable pressure loss. When the beer is cooled by passage through the cooler 46, the solubility of the gas is further increased and this compensates for the pressure loss which inevitably occurs in the beer as a result of passage through the extended coils of the cooler 46.

Within the pressure reducer 48, the pressure is further reduced to 200 to 50 kPa (gauge pressure) in a careful and controlled manner so as to bring it very close to or in a supersaturated state. In Fig 5, this is shown by the pressure profile passing through P_{ET2}. The pressure at the tap is shown in Fig 5 as P_T. Atmospheric pressure is indicated by P_A.